The **Information Systems & Decision Sciences Department**
has the pleasure to invite you to its

Special series of 4 research seminars by:

S. DAS, SID *Invited Professor*

Research Chair Professor (Statistics and Actuarial studies)

Indian Institute of Management Bangalore

shubbo@IIMB.ERNET.IN

May 9, 2007	N405, Nautile, 4th floor	At 4:30 pm
May 16, 2007	N305, Nautile, 3rd floor	
May 23, 2007		
May 30, 2007		

In collaboration with

ESSEC
CENTRE DE RECHERCHE

Open to:	***Faculty*, *PhD/Doctorate* and *Master Assurance/Finance students***
May 9, 16:	***People particularly interested in the domain of finance, assurance, probability and statistics***
***May 23, 30*:**	***Domain of marketing, applied statistics, operations research***

Contact: Patricia Fernandez (3245) fernandez@essec.fr

May 9: Joint Life Insurance Products with Differential benefits and premiums to the policyholders

In this work, actuarial justification is explored for equal or unequal sharing of premiums and benefits between policyholders in a product involving joint lives. The analysis reveals a fundamental difference between endowment and assurance type of products in this regard. In assurance plans, there is a clear basis for differential structure in terms of sharing premium payment. In pure endowment plans, the default system of equal premium for equal benefit may be more justified although implications on other alternatives are also considered. A justification is derived for such an alternative through appropriate discount figures as compared to the individual live policies. An alternative actuarial principle is also suggested to deal with joint endowment plans and solutions have been worked out under this framework. Finally we will deal with the situation when the insured lives are dependent, say through a common shock model.

Related Publication:

Joint Life Insurance Policies with Differential Benefits and Premia to the Policyholders, **S. Das**, IIM Bangalore Working Paper 208 [Currently with APJRI for journal publication– an early draft received the ‘best paper award’ in 7th APRIA conference]

May16: In Search of A FAIR BONUS-MALUS System

In automobile insurance, among other general insurance policies, it is quite common to reduce the premium by a factor in case the insured does not make any claim in a given period (year). This is popularly known as NCD or no-claim-discount. Equally popular is the practice of increasing (known as 'loading') the premium, in case a claim is made. In affect, this leads to a multi-layer premium policy, where any particular policyholder's premium is decided on the history of claims (s)he made in the immediate past few years. The number of such levels and the NCD/loading amounts constitute a particular bonus-malus system. Appropriate designing of such a system is a matter of eternal debate in insurance industries across the world. In this presentation, we will discuss different ways of formulating the system keeping the actuarial fairness as the top criterion. Simplicity of the system is yet another desirable consideration and Markov-chain based formulation provides a perfect platform for that.

Thus we consider a discrete time parameter Markov chain, where the state space consists of the different levels of the premium, and the state of a particular insured shift randomly from an year to the next, while the movement given the past history is dependent only on the immediate past status. While this MC structure is simple, this is also realistic given the scheme in many countries.

The randomness of the transition is governed by the transition probability of causing an accident in a given year. We model this probability to be varying depending on quality of the driver. For the most part, we would be considering a finitely many groups of policyholders (drivers) characterized by respective probabilities of getting involved in an accident. The claim (damage) amount is assumed to have a known distribution, a log-normal one, for the sake of illustration. The parameters of this distribution need to be in consistence with the basic premium level(s). We work under two possible behaviors of all the policyholders. In the simpler version, we consider a driver would claim whenever (s)he incurs a damage from accident. In the second framework, (s)he would make a claim only if the (claim) damage amount exceeds the potential loss in the form of losing NCD. In making this judgment (s)he would need to take into account the effect of any more accident in the near future, and it is assumed that (s)he would rule out the such eventuality. This assumption is reasonable in the sense that, in reality, most drivers think very positively about their own driving ability; also, one is likely to be extra careful after getting involved in an accident.

We obtain the stationary distribution for each group of policyholders. This reflects the distribution of a particular group over the various levels of premium in the long run. For example, one can obtain the percentage of 'good' drivers expected to receive the fully discounted rate in the long run. A comparative study of these stationary distributions over the various groups considered, form the basis of appropriateness of the assumed NCD system. We look at the feasibility of evolving a NCD system which would be fair in the sense that the premium collected from any specific group would cover the expected claim amount from that group asymptotically.

May 23: Discrete Optimization Problems with Random elements

We consider stochastic discrete optimization problems (SDOPs) (eg. Knapsack, Travelling salesman problem etc) i.e. problems where some of the ‘elements’ (e.g. cost of a path) could be random. In the first (most) part we will consider problems in which the feasibility of a solution does not depend on the particular values the random elements in the problem take. Given a regret function, defined in this work, we introduce the concept of the risk associated with a solution, and define an optimal solution as one having the least possible risk. We show that for SDOPs with one random element and with min-sum objective functions a least risk solution for the stochastic problem can be obtained by solving a non-stochastic counterpart where the latter is constructed by replacing the random element of the former with a suitable parameter. We show that the above surrogate is the mean if the stochastic problem has only one symmetrically distributed random element. We obtain bounds for this parameter for certain classes of asymmetric distributions and study the limiting behavior of this parameter in details under two asymptotic frameworks.

For similar SDOPs having multiple random elements, while the optimal solution, for a linear regret function, can be obtained by solving an auxiliary (non-stochastic) discrete optimization problem (DOP), the situation becomes complex under general regret function. We characterize a finite number of solutions which will include the optimal solution. We establish through various examples that the results from single dimension can be extended only partially for SDOPs with additional characteristics. We present a result where in selected cases, a complex SDOP may be decomposed into simpler ones facilitating the job of finding an optimal solution to the complex problem. We also propose numerical local search algorithms for obtaining an optimal solution.

In the final part we would consider a binary knapsack problem with random budget constraint (which violates framework of the earlier work). We propose two different formulations of this problem, based on different ways of handling infeasibility, and propose an exact algorithm and a local search based heuristic to solve the problems represented by these formulations. We would also present the results from some computational experiments.

Co-authors:

1. Diptesh Ghosh, IIM Ahmedabad

2. Pranab K. Mandal, University of Twente

May 30: Constrained multivariate methods: Principles and applications

Interpretation of weights is an important issue in multivariate methods like canonical correlation (CC) analysis. It is not uncommon to encounter situations in practice where one can end up with two (or more) very different sets of weights [or, coefficients of original variables in the canonical variables (CV's) which lead to similarly high correlation or variance, even when there is no multiplicity of roots. In those cases, it is difficult to attach meaning to these weights especially if one would like to treat the CV's as some sort of *representative* of their groups. For example, non-negativity (NNG) and/or convexity are some of the desirable properties in general situations. In many practical situations (e.g. educational testing problems, neural networks), certain more structured restrictions on the coefficients may be in order. These lead to the need for the development of studies where this type of restrictions will be incorporated in the maximization procedure. We obtained the solution to the CC problem under the NNG restriction on coefficients and its relationship with traditional CC's. The analysis was then extended to more general form of inequality constraints, and also when the restrictions are present only on some of the coefficients. Off late such constrained analysis and the methodology in this work are now routinely used in fMRI data analysis (H. Knuttsson, O. Friman et al.). Other avenues of application are in the domain of discriminant analysis which will be covered in the presentation.

The issues and the solutions are broadly similar in the case of principal component analysis (PCA) and related Factor analysis. Non-significant values of coefficients in a factor or their values which are contrary to the spirit of the problem, may not only present an incorrect picture of the efficiency of the analysis, but it also creates problem for the decision maker in terms of interpreting and justifying the nature of the solution. This work attempts to have better interpretable factors by implementing constrained principal component analysis, where the natural (as per expectation prior to the analysis or post-standard analysis) restrictions on the coefficients would be built-in the optimization framework.

In the concluding part, we will discuss relevance to Data envelopment analysis (DEA). DEA is often compared with PCA in ranking DMUs. But, traditional PCA is ill-suited for such a comparison since signs of the weights should be predetermined (typically nonnegative) in those PCs. We consider PCA where such constraints are built in the optimization procedure and draw parallel with DEA. Constrained principal components of higher orders are developed for this purpose. In the second phase of the interplay between the two analyses, we inspect the relevance of constrained PCA in PCA-DEA where the input and output variables to be used in DEA are selected by constrained PCA.